Attorney Docket No. 042390.P11442C

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application for:

Brian A. Leete

Serial No.: 10/698,154

Filed: October 31, 2003

For: **A METHOD AND APPARATUS FOR HIGH THROUGHPUT SHORT PACKET TRANSFERS WITH MINIMUM MEMORY FOOTPRINT**

Examiner: Angel L. Casiano

Art Group: 2182

37 C.F.R. 1.131 DECLARATION

I, Brian A. Leete, began working on the High Throughput Short Packet Transfers with Minimum Memory Footprint invention prior to December 5, 2000. On December 5, 2000, I submitted an Intel Invention Disclosure form to my employer, Intel, Inc. (please find the attached copy of the submitted disclosure form). After having the disclosure reviewed and selected for patenting, the disclosure was submitted to the Intel Patent Database Group on January 24, 2001 (see received stamp on the disclosure form). The Patent Database Group opened a file and forwarded the file, including the disclosure form, for distribution to a responsible partner of Blakely, Sokoloff, Taylor and Zafman, LLP. The application was then assigned to Steven Laut, who is the attorney of record. I met with Steven Laut in April of 2001 to answer questions regarding the disclosure form. Steven Laut prepared the application and forwarded a final draft for my review in the first week of June 2001. I approved the application after a few revisions in the same week. The application was forwarded to Intel's Quality Review attorney the second week of June 2001. The application was approved on June 27, 2001. The application was then filed on June 29, 2001. I was diligent in filing the application. As of the date the

disclosure (December 5, 2000) was submitted to Intel (the assignee), and by the time the application was filed, I was only aware of the Enhanced Host Controller Interface (EHCI) Specification for a Universal Serial Bus, rev. 0.95, November 10, 2000. I asserted this version of the EHCI specification in the background section of the application's specification. I submit all of the above facts and statements are true.

8/25/06 Brian Leete

Date Brian A. Leete

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INTEL INVENTION DISCLOSURE

ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

located at http://legal.intel.com

DATE: 12/5/00 SOFTWARE/INTERNET/IAL/ISL COMM.

It is important to provide accurate and detailed information on this form. The information will be used to evaluate your invention for possible filing as a patent application. When completed and signed, please return this form to the **Legal Department at JF3-147. You can submit electronically via e-mail to "invention disclosure submission" if all of the information is electronic, including drawings and supervisor approval.** If you have any questions, please call **264-0444.**

1. Inventor: Leete (Last Name) Brian (First Name) A (Middle Initial)

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Supervisor* _____ WWID _____ Phone _____ M/S: _____

***If you are unsure of this information, please discuss with your manager.**

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

2. Title of Invention: High Throughput Short Packet Transfers with Minimum Memory Footprint

3. What technology/product/process (code name) does it relate to (be specific if you can):
USB 2.0, Enhanced Host Controller Interface (EHCI)

4. Include several key words to describe the technology area of the invention in addition to # 3 above: _____

5. Stage of development (i.e. % complete, simulations done, test chips if any, etc.): _____
Design

6. (a) Has a description of your invention been, or will it shortly be, published outside Intel:

NO: X YES: _____ If YES, was the manuscript submitted for pre-publication approval? _____

IDENTIFY THE PUBLICATION AND THE DATE PUBLISHED: _____

(b) Has your invention been used/sold or planned to be used/sold by Intel or others?

NO: X YES: _____ DATE WAS OR WILL BE SOLD: _____

(c) Does this invention relate to technology that is or will be covered by a SIG (special interest group)/standard/ or specification?

NO: _____ YES: ___USB___ Name of SIG/Standard/Specification: USB 2.0

(d) If the invention is embodied in a semiconductor device, actual or anticipated date of tapeout? _____

(e) If the invention is software, actual or anticipated date of any beta tests outside Intel None

7. Was the invention conceived or constructed in collaboration with anyone other than an Intel blue badge employee or in performance of a project involving entities other than Intel, e.g. government, other companies, universities or consortia? NO: __X__ YES: _____ Name of individual or entity: _____

8. Is this invention related to any other invention disclosure that you have recently submitted? If so, please give the title and inventors: _____

Rev. 15, 8/00

Summary of Invention

This invention describes a method for ordering EHCI Host Controller QTD data structures to maximize bulk IN bus throughput in the presence of short packets, with minimum memory footprint.

Background

The USB 2.0 EHCI Host Controller is a bus master on the PCI bus. It independently traverses linked memory structures created and maintained by software (the host controller driver) to initiate transactions on the USB. There are two main memory structures used to specify Bulk transactions on the bus, a Queue Head and a Queue Element Transfer Descriptor (QTD). A Queue Head contains all of the endpoint specific information required. It also contains linkages to a list of QTDs. A QTD represents all or part of a buffer passed to the Host Controller Driver from a higher level driver, or user level application. A QTD can represent up to 20KB worth of data to be received from the device. A QTD contains 2 linkage pointers to other data structures, a Next Pointer and an Alternate pointer. These pointers point to the next QTD to execute. When the host controller completes a QTD normally, it will follow the Next Pointer. When the device returns less data than requested by the QTD, a short packet condition results. When the host controller receives a short packet, the host controller follows the alternate pointer.

1. Describe in detail what the components of the invention are and how the invention works.

This invention consists of N small banks (e.g 3 QTDs) of QTDs, one for each buffer posted to the host controller driver. Each bank of QTDs is circularly linked, that is the next pointer in each QTD points to the next QTD in the bank, and the Next pointer of the last QTD points to the first QTD in the list. The alternate pointer of each QTD in the list points to the first QTD in the next bank (representing the next sequential buffer posted to the host controller driver). As the host controller consumes data from the QTDs, and executes transactions on the USB, the host controller driver continually re-initializes and re-uses the statically defined QTDs corresponding to the currently active buffer. When the Host Controller Driver initializes the last QTD of the buffer it sets the Next Pointer of that QTD to the first QTD in buffer N+1. If all of the QTDs in buffer N complete normally, the host controller immediately follows the Next pointer in the last initialized QTD and begins servicing the QTDs in buffer N+1. If any of the QTDs in buffer N terminate with a short packet, the host controller will follow the alternate pointer to the first QTD of buffer N+1. The same pattern continues for N buffers.

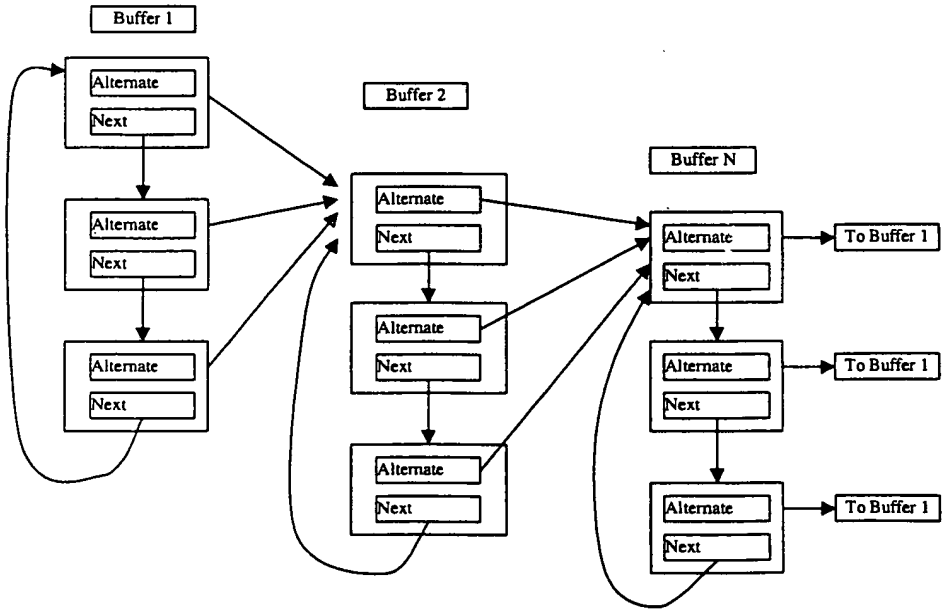
2. Describe advantage(s) of your invention over what is done now.

Currently there are 3 other methods for organizing QTDs. The first involves creating all of the QTDs necessary to represent at least 2 buffers submitted. Each alternate pointer of buffer N points to the first QTD of buffer N+1. This approach requires a large memory footprint to initialize all of the QTDs required to represent both buffers.

A second approach is to initialize all the Alternate pointers to point to a dummy QTD. When a short packet is received, the host controller will vector to the dummy QTD. Software can then detect the short packet and re-initialize the data structures. Since Software can only detect a short packet condition when the hardware asserts an interrupt, and hardware interrupts occur only at fixed intervals, the time after the short packet is received, and before the interrupt is serviced is wasted. Therefore this approach has a small memory footprint, but low throughput.

The third approach is to initialize the alternate pointers to NULL (with a t-bit set). In this case, when a short packet is received from the device, the host controller stops on the QTD that received the short packet buffer. Software must then initialize the data structures to resume streaming, and is subject to the same delay as the solution above.

3. YOU MUST include at least one figure illustrating the invention. If the invention relates to software, include a flowchart or pseudo-code representation of the algorithm.



Each box represents a QTD. Each column of QTDs represents the QTDs required for a single buffer.

4. Value of your invention to Intel (how will it be used?).

For many input devices such as Ethernet Controllers, mass storage devices (Disks, etc.) it is impossible for the host to know in advance how much data the device will return for any given bus transaction. For these devices, the host controller initializes QTDs to account for the largest possible transaction that can be received from the device. The device then typically returns short packets to the host. This invention will be used in the development of an efficient (in terms of memory footprint and bus utilization) host controller driver in the presence of this class of devices.

5. Explain how your invention is novel. If the technology itself is not new, explain what makes it different.

This technology makes use of new features of the USB 2.0 EHCI host controller. This invention in novel, because it allows full bus utilization w small memory footprint for all buffer sizes.

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6. Identify the closest or most pertinent prior art that you are aware of.

None

7. Who is likely to want to use this invention or infringe the patent if one is obtained and how would infringement be detected?

Infringement could be detected by looking at Host controller data structures in memory, with a trace of the USB.

DATE: _____ SUPERVISOR: _____

BY THIS SIGNING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID